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A fill-rate component was developed and tested for the Marine Corps' program management module, which governs the allocation of recruit applicants to enlisted program guarantees within the Automated Recruit Management System (ARMS). Marine Corps policy directives led to the formulation of a utility component capable of meeting program fill-rate requirements. The resulting component was tested by simulating recruit assignments and assessing model performance characteristics. Programs filled at nearly uniform rates for all 9 sample months examined. The results of assignment by model (ABM) were compared to actual assignment (AA) results. The ABM resulted in personnel allocation to enlisted guarantee programs at more uniform accession rates than AA.

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MARINE CORPS RECRUIT CLASSIFICATION: THE PROGRAM FILL-RATE COMPONENT

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January 1985

MARINE CORPS RECRUIT CLASSIFICATION: THE PROGRAM FILL-RATE COMPONENT

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FOREWORD

The purpose of this research, which was conducted under project CF-63-521-080-101-04.26 (USMC Optimal Enlistment Guarantees), was to develop and test a utility component to govern the allocation rates of enlisted program guarantees to recruit applicants. This component is one of several to be developed for use in the Recruit Enlistment Guarantee Allocation (REGAL) model, which is scheduled to replace the Marine Corps' program management (PM) module. The PM module governs the allocation of recruits to enlistment program guarantees within the Automated Recruit Management System (ARMS).

This technical report, the second in a series, documents the program fill-rate component's development and initial evaluation. The first report (NPRDC TR 84-46) documented the minority fill-rate component development.

These research results are intended for program managers within MPI-40, program users within the Marine Corps Recruiting Service, and Department of Defense researchers involved in developing personnel allocation systems.

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SUMMARY

Problem

At present, Marine Corps Recruiting Service personnel assign recruit applicants to enlisted guarantee programs (training school opportunities) by employing a paper-and-pencil tally system. The process requires the service to monitor and control program accession rates manually. The lack of automation prevents appropriate feedback on the need for recruiters to decrease the allocation rate of popular programs and to increase the corresponding rate of less popular programs. An automated procedure is needed to assist recruiters in achieving desired program accession rates for all programs.

Purpose

The purpose of this research was to design, construct, and test a program fill-rate component to govern program allocation rates within the Recruit Enlistment Guarantee Allocation (REGAL) computer model, which is the planned replacement of the program management module in the Marine Corps' Automated Recruit Management System (ARMS).

Approach

Marine Corps directives led to the formulation of a utility component capable of meeting accession fill-rate requirements. The resulting experimental form was tested in a simulation procedure using Marine Corps accession data. Results from the simulation procedure were evaluated and compared to actual Marine Corps assignments.

Results

The use of the program fill-rate component in the assignment simulations resulted in the filling of programs at nearly uniform rates for each of the 9 sample months used in the study. The results of assignment by model (ABM) were compared to actual assignment (AA) results. A discrepancy measure, C_t, which was used to assess the production of uniform accession rates, was approximately five times smaller under ABM than under AA. The ABM procedure resulted in superior allocations that yielded nearly uniform accession rates.

Conclusions

The utility component developed to govern program allocation rates within the REGAL model was successfully constructed and tested, allocating personnel more closely to objectives calling for uniform accession rates than the assignments actually made by recruiters.

The component enables the Marine Corps Recruiting Service to monitor and control program accession rates more effectively than with a paper-and-pencil tally. It allows instantaneous information feedback so that recruiters can increase or decrease program allocation rates as required.

Recommendations

It is recommended that Marine Corps managers at MPI-40 and the Marine Corps Recruiting Service:

1. Incorporate the program fill-rate component into the REGAL module within the ARMS.

2. Initiate research to develop procedures that predict the optimal program fill-rates that will be needed to meet Marine Corps manpower objectives.

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INTRODUCTION

Problem

At present Marine Corps Recruiting Service personnel assign recruit applicants to enlisted guarantee programs (training school opportunities) by employing a paper-and-pencil tally system. The process requires the service to monitor and control program accession rates manually. The lack of automation prevents appropriate feedback about the need for recruiters to decrease the allocation rate of popular programs and to increase the corresponding rate of less popular programs. An automated procedure is needed to assist recruiters in achieving desired program accession rates for all programs.

Background

Approximately 65 percent of all Marine Corps recruit applicants receive training school guarantees upon entering the service.[1] Each guarantee consists of a contractual obligation to train an applicant in a skill area contained within an enlistment program option (see Table 1).

Marine Corps recruiters can allocate a program option to a recruit applicant if two primary requirements are met: (1) the program's availability, and (2) the applicant's ability to meet its minimal prerequisites. In other words, Marine Corps policy defines the allocation process up to the point of screening a person in or out of a particular program.

However, the steps taken by recruiters after this initial screening are not well known and vary from one recruiter to another. This lack of consistency in allocation decisions produces differential accession rates: Some enlisted guarantee programs fill much faster than others.

In 1982, Marine Corps officers within MPI-40 directed that a classification model be developed based on the Air Force Procurement Management Information System (PROMIS) model (Ward, Haney, & Pina, 1978) and the Navy's Classification and Assignment within PRIDE (CLASP) model (Kroeker & Rafacz, 1983). Among the objectives to be achieved by the application of the model was the allocation of enlisted program options (see Table 1) at rates compatible with managerial directives.

Purpose

The purpose of this research was to design, construct, and test a program fill-rate component to govern program allocation rates within the Recruit Enlistment Guarantee Allocation (REGAL) computer model, which is the planned replacement of the program management module in the Marine Corps' Automated Recruit Management System (ARMS).

---

[1]Personal communication with LCOL R. Carter (MPI-40) April 1984.

Table 1

Marine Corps Enlistment Guarantee Programs

Code	Program Title
A5	Avionics
AA	Aviation Ordnance
AB	Support/Administration/Anti-air Warfare
AC	Technical Support
AD	Aircraft Maintenance
G2	Personnel Administration
G3	Motor Transport Operator
G6	Food Service
G7	Computer Operators
G8	Military Police/Correction Specialist
ZD	Combat Support
ZE	Administrative
ZF	Logistic, Supply, Transportation, Repair Services, Disbursing, and M. C. Exchange
ZG	Mechanical/Electrical
ZH	Combat
ZJ	Infantry
ZK	Radio Communications
ZL	Electronics

APPROACH

Discussions with Marine Corps officials (MPI-40) produced the following guidelines for program fill-rate component development:

1. The component should include a feedback function based on a particular program's fill percentage and should reflect differential fill-rate utility at any given moment in the recruiting period.

2. The component should be designed for integration with other modular utility functions but should perform calculations independently of them.

The simplest configuration of the model would be one designed to fill programs at uniform rates. However, it should be easily modifiable to achieve potential service objectives for differential program fill rates.

Sample

The original sample consisted of all recruits who entered the Marine Corps between July 1981 and March 1982, the most current sample available, and representative of recruits now entering the Marine Corps. Recruit data were taken from the ARMS centralized data base maintained by the Marine Corps in Kansas City. Out of the total number of 8598 recruit data records, 4413 were used in this research. The remainder, records of recruits who required waivers,[2] were eliminated from the study because they could not be assigned by the computer model and consequently could not contribute to meaningful comparisons. Table 2 shows the sizes of the nine recruit subsamples used in this research.

Table 2

Marine Corps Recruit Sample Sizes

Recruit Entry Period	Subsample n
July 1981	369
August 1981	509
September 1981	537
October 1981	486
November 1981	522
December 1981	457
January 1982	630
February 1982	547
March 1982	356
Total	4413

Program Fill-rate Component Development

The utility generator developed for the program fill-rate component was formulated for the simplest configuration, with the objective of producing uniform program accession rates. The program fill-rate utility for a given person-program match was defined as the difference between a program's fill proportion and the proportion across all programs at any given time. Utility points are added or subtracted for a given person-program match depending on relationship between each program's fill proportion and the overall accession rate. For example, if a program's fill proportion was less than the overall accession proportion, utility points were added to increase the likelihood of assigning a recruit to that program.

[2]Waivers may be granted on a case-by-case basis to recruit applicants whose entrance qualifications fall short of required minimums.

The statistic that measures the degree to which a given program's fill proportion differs from the current accession proportion is expressed as $P_{jt}-P^*_t$ where

P_{jt} is the fill proportion within program j at time t, and

P^*_t is the accession proportion across all programs at time t.

The utility equation based on the above statistic is shown as

$$U_{jt} = 50.0 + \frac{10(P^*_j - P_{jt})}{R} \qquad (1)$$

where

U_{jt} is the utility value associated with the allocation of a person to program j at time t, and

R is a constant (defined in the appendix).

A computer program based on equation 1 was developed to calculate program fill-rate utility values for applicants.

Allocation Procedure

The program fill-rate component, along with other utility components, was designed to function within ARMS. To incorporate this computer program and, thus, to generate payoff values[3] for person-program matches, system flow charts were prepared and an allocation computer program was developed (Kroeker & Folchi, 1984). Each component was designed in modular form so that it could easily be integrated into the system (see also Kroeker & Rafacz, 1983). The allocation system incorporating the program fill-rate utility component was used to generate assignment payoff values falling into a range of 1-100, as illustrated by a hypothetical example in Table 3.

Table 3

Payoff Values for a Hypothetical Recruit Applicant

Recommended Program	Payoff Value
ZJ	100
AD	94
AB	91
ZK	85
ZG	80
ZD	76
:	:

[3]Payoff values are also called optimality index values (see Kroeker & Rafacz, 1983).

Recruit Assignment Simulation

The allocation system using program fill-rate utilities was used to test the component in a simulated set of assignments. For the 4413 persons in the research sample, the allocation program produced each recruit's program options as an ordered list and assigned the recruit to the first program on the list. The program allowed only programs for which the recruit qualified and for which an open quota existed to appear on the list. This process was referred to as the allocation by model (ABM) procedure.

The ABM procedure is based on a criterion function that expresses the utility of a person-program match in relation to a decision index (DI) mean. A DI score reflects the degree of expected proficiency resulting from a particular person-program match. Ward (1959) and Kroeker and Rafacz (1983) have discussed the role of the DI mean in the allocation procedure more fully. The simulated assignments were examined and compared to the actual assignments (AA) made by recruiters and recorded in the data base described earlier.

Measuring Program Fill Discrepancies

To compare the performance of AA and ABM, it was necessary to measure the difference at various points in time between each program's fill rate and the overall accession rate. The discrepancy between the fill proportion of a given program, j, and the accession proportion, P^*_t, across all programs at time t was defined by equation 2.

$$\delta_{jt} = P_{jt} - P^*_t \tag{2}$$

where P_{jt} and P^*_t have been defined on page 4.

A measure of the extent to which the fill proportions of all programs deviate from the accession proportion at any given moment is defined by the statistic, C_t, defined in equation 3.

$$C_t^2 = \frac{\sum_{j=1}^{18} w_{jt}\,\delta_{jt}^2}{\sum_{j=1}^{18} w_{jt}} \tag{3}$$

where w_{jt} is the number of accessions within program j at time t. The size of C_t^2 reflects the state of the system with respect to fill discrepancy at time t. Clearly, small C_t^2 values are desired.

Empirical values of the discrepancy statistic, C_t, were obtained by evaluating equation 3 after each accession. Mean values of C_t were obtained from successive groups of 15 accessions for each assignment procedure.

RESULTS AND DISCUSSION

Assignment Simulation Results

When the program fill-rate component was used to determine the utility of each person-program match, each recruit was assigned to the enlisted guarantee program showing the highest utility value. Assignments were made under the assumptions that (1) program vacancies existed, and (2) minimum program prerequisites had been met. DI mean parameters of 5000 were used for all programs. A typical set of profiles showing the numbers of persons assigned within each program at selected times is displayed in Table 4. Each program was filled at a nearly uniform rate (see Tables 4 and 5). This pattern of fill rates was characteristic of each of the nine subsamples used in the research.

Comparison of Two Allocation Procedures

To compare results obtained under the ABM and AA procedures, the deviations from a uniform accession rate were assessed by using the discrepancy measure (C_t) described previously. Average C_t values were calculated for successive groups of 15 accessions. Figure 1 shows the changes in the C_t mean as successive groups were processed in the July sample. The upper curve shows the changes in C_t mean under the AA condition while the lower one shows changes under ABM. Figures 2-9 show a similar pattern of discrepancy (C_t) curves across the data samples. In each sample, the discrepancy measure under AA increases sharply and stabilizes in the 0.13 to 0.15 region. For all but one sample (Figure 9) the discrepancy measure under ABM shows an initial decrease and a subsequent stabilization in the 0.01 to 0.03 region. Under ABM, the measure reaches a stabilization point after approximately 115 ± 50 accessions have entered the system.

All samples show that deviations from uniform accession rates are effectively minimized under the ABM condition. In other words, the average C_t value under ABM is approximately five times smaller than under AA.

Table 4

Number of Recruits Assigned at Selected Time Points
October 1981 Subsample

	Number by Time Point[a]																
Program	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P[b]	Quota
A5	1	2	3	4	5	6	7	8	9	10	11	11	11	13	15	16	16
AA	1	1	2	3	4	5	5	6	7	8	8	8	9	10	11	12	12
AB	1	2	3	4	5	5	6	7	8	9	10	11	12	12	13	14	14
AC	1	2	4	6	8	9	11	13	14	16	16	18	18	21	24	25	25
AD	2	3	5	6	7	9	10	12	13	15	17	18	20	21	22	23	24
ZJ	3	5	9	11	13	16	18	21	24	27	30	33	37	41	42	44	45
G2	1	3	3	5	6	7	8	9	10	11	12	13	15	16	17	18	18
G3	3	6	8	11	13	16	19	22	24	27	30	33	36	38	40	46	46
ZK	3	6	9	11	14	17	21	23	26	29	32	35	39	41	43	46	47
ZL	0	3	5	7	9	11	13	15	16	18	19	20	20	24	27	28	29
G6	1	2	3	4	5	5	6	7	9	9	10	11	12	14	14	14	14
G7	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	4
G8	1	2	3	4	5	6	7	8	9	10	11	12	12	13	14	15	15
ZD	3	5	8	10	13	16	19	21	23	26	30	33	35	37	40	42	42
ZE	2	4	5	7	9	10	12	14	16	18	19	21	23	24	26	27	27
ZF	2	5	7	9	11	14	16	19	21	23	26	28	31	32	35	36	37
ZG	3	6	9	13	16	19	23	25	29	31	35	39	42	44	47	51	52
ZH	1	2	3	4	5	7	7	8	9	10	11	13	14	15	16	19	19
Total																	486

[a]Time is expressed in terms of numbers of persons accessed. Each point represents an additional 30 accessions counted from the previous one. For example, 30 accessions at A, 60 at B, 90 at C, etc.

[b]An accession level of 480 persons is reached at time P. All quotas are filled when all 486 persons in the sample have been assigned.

Table 5

Percentage of Recruits Assigned at Selected Time Points
October 1981 Subsamples

	Percentage by Time Point[a]															
Program	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P[b]
A5	06	12	19	25	31	38	44	50	56	62	69	69	69	81	94	100
AA	08	08	17	25	33	42	42	50	58	67	67	67	75	83	92	100
AB	07	14	21	28	36	36	43	50	57	64	71	79	86	86	93	100
AC	04	08	16	24	32	36	44	52	56	64	64	72	72	84	96	100
AD	08	12	21	25	29	38	42	50	54	62	71	75	83	88	92	100
ZJ	07	11	20	24	29	36	40	47	53	60	67	73	82	91	93	98
G2	06	17	17	28	33	39	44	50	56	61	67	72	83	89	94	100
G3	07	13	17	24	28	35	41	48	52	59	65	72	78	83	87	100
ZK	06	13	19	23	30	36	45	49	55	62	68	74	83	87	91	98
ZL	00	10	17	24	31	38	45	52	55	62	66	69	69	83	93	97
G6	07	14	21	29	36	36	43	50	64	64	71	79	86	100	100	100
G7	25	25	25	25	50	50	50	50	75	75	75	75	100	100	100	100
G8	07	13	20	27	33	40	47	53	60	67	73	80	80	87	93	100
ZD	07	12	19	24	31	38	45	50	55	62	71	79	83	88	95	100
ZE	07	15	19	26	33	37	44	52	59	67	70	78	85	89	96	100
ZF	05	14	19	24	30	38	43	51	57	62	70	76	84	86	95	97
ZG	06	12	17	25	31	37	44	48	56	60	67	75	81	85	90	98
ZH	05	11	16	21	26	37	37	42	47	53	58	68	74	79	84	100

[a] Time is expressed in terms of numbers of persons accessed. Each point represents an additional 30 accessions counted from the previous one. For example, 30 accessions at A, 60 at B, 90 at C, etc.

[b] An accession level of 480 persons is reached at time P. Hence, not all quotas have been filled.

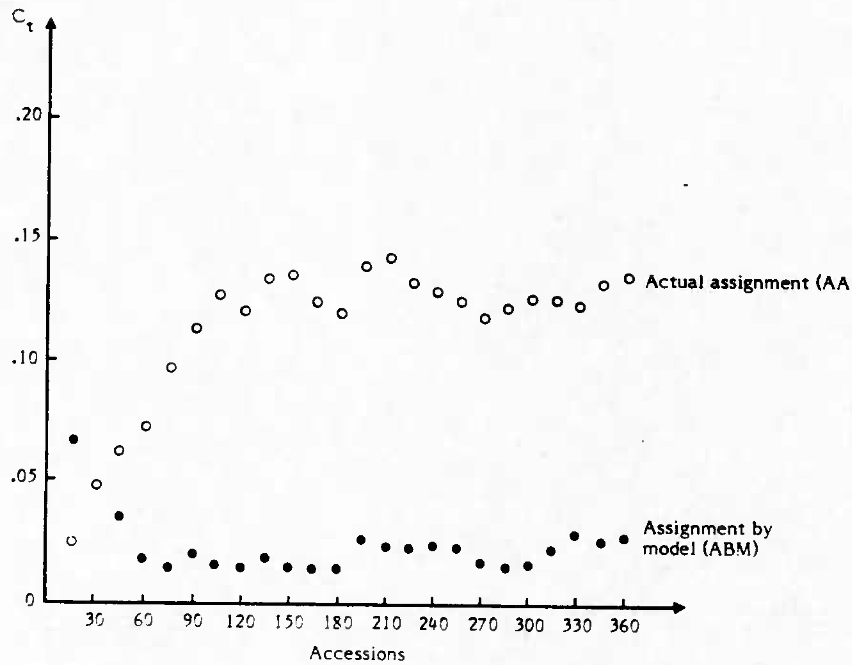

Figure 1. Assignment discrepancy (C_t) across time, July 1981.

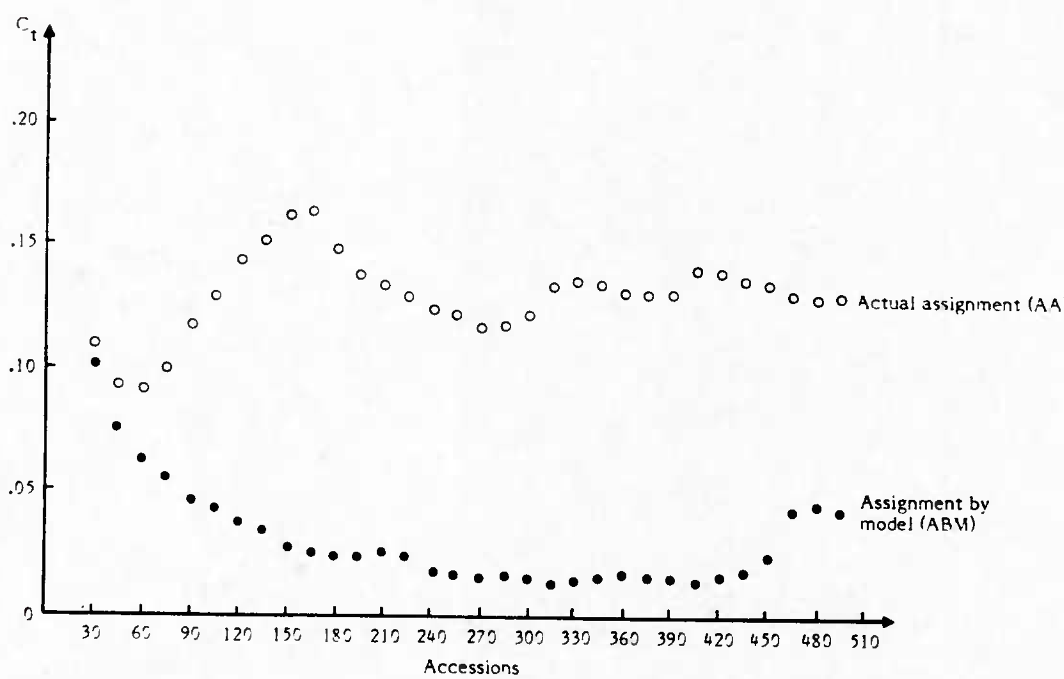

Figure 2. Assignment discrepancy (C_t) across time, August 1981.

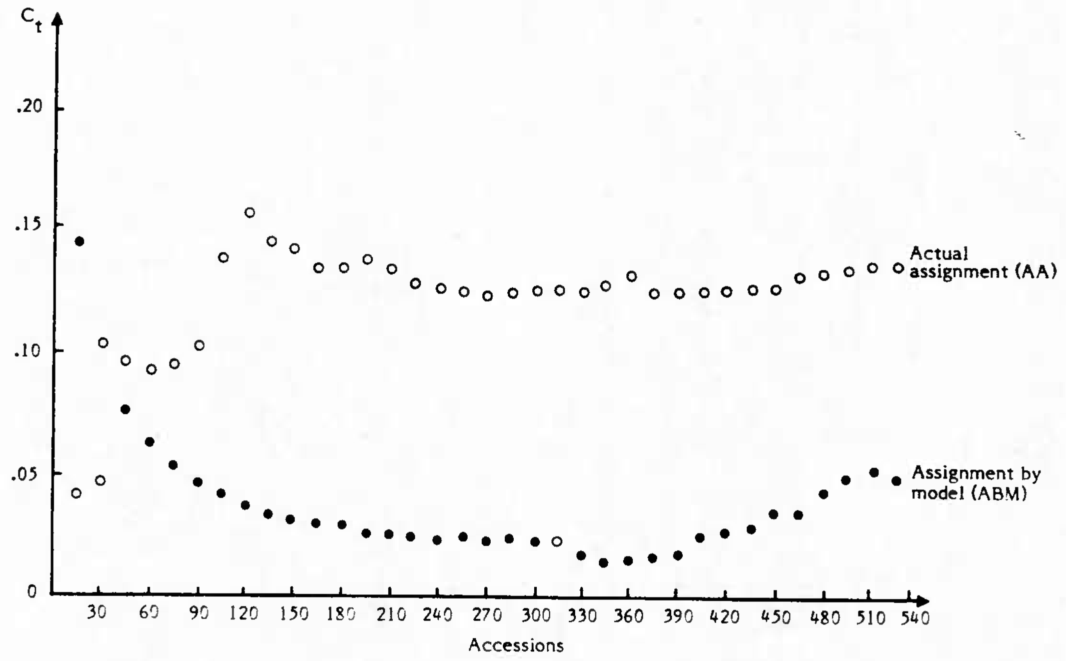

Figure 3. Assignment discrepancy (C_t) across time, September 1981.

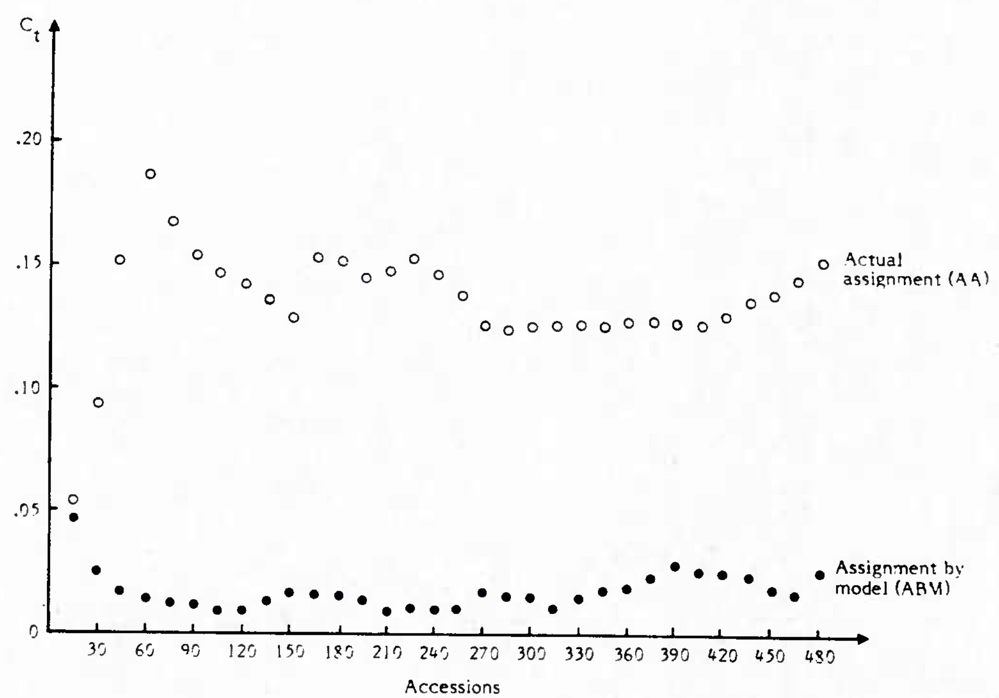

Figure 4. Assignment discrepancy (C_t) across time, October 1981.

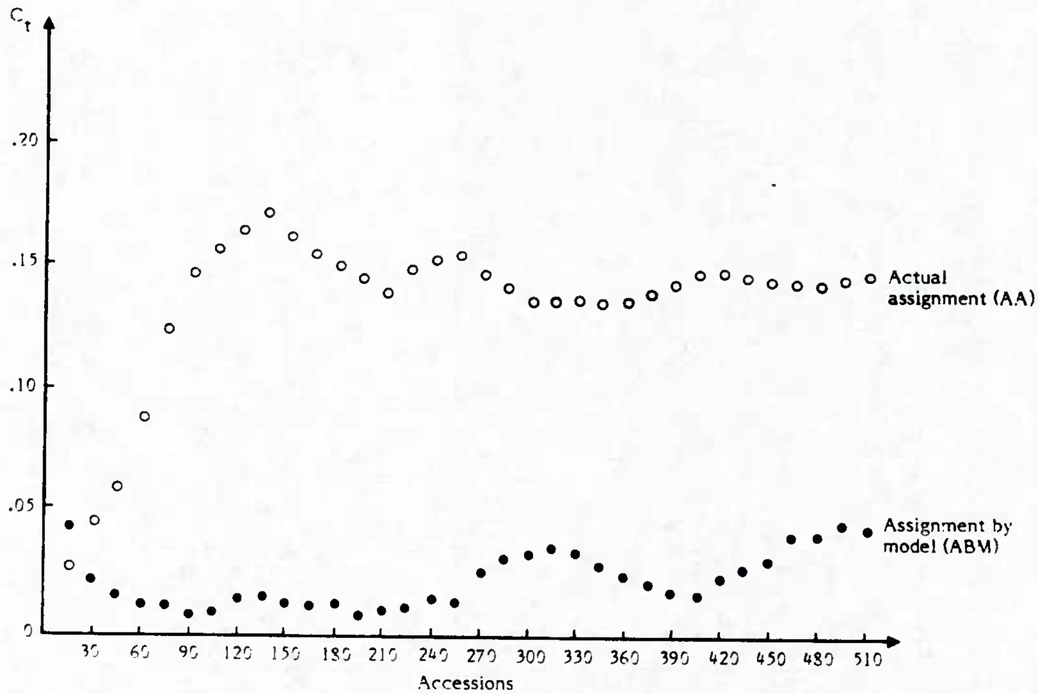

Figure 5. Assignment discrepancy (C_t) across time, November 1981.

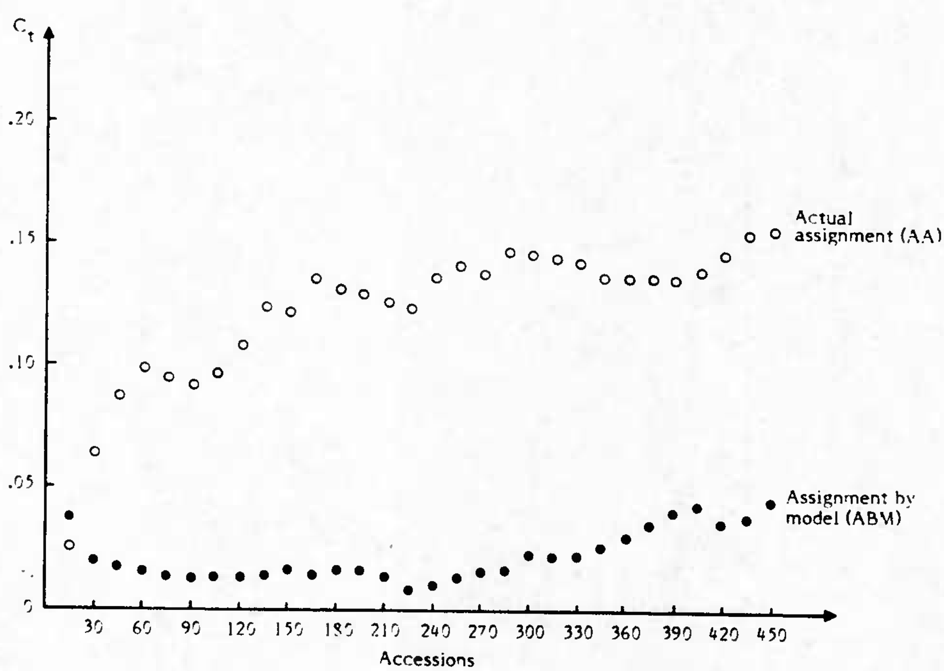

Figure 6. Assignment discrepancy (C_t) across time, December 1981.

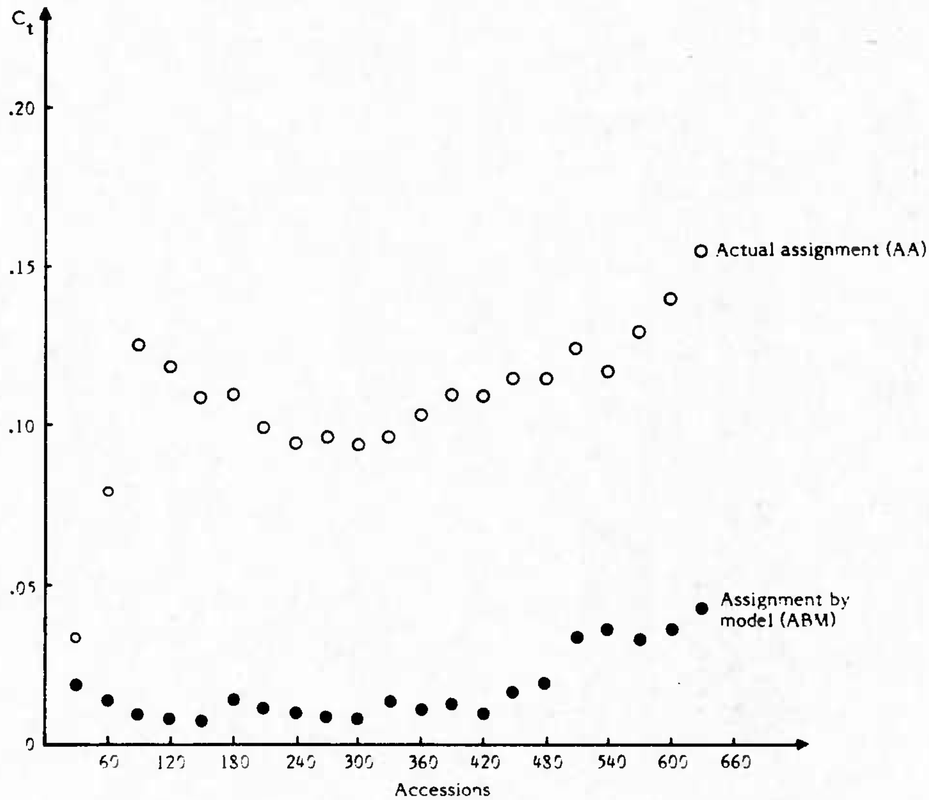

Figure 7. Assignment discrepancy (C_t) across time, January 1982.

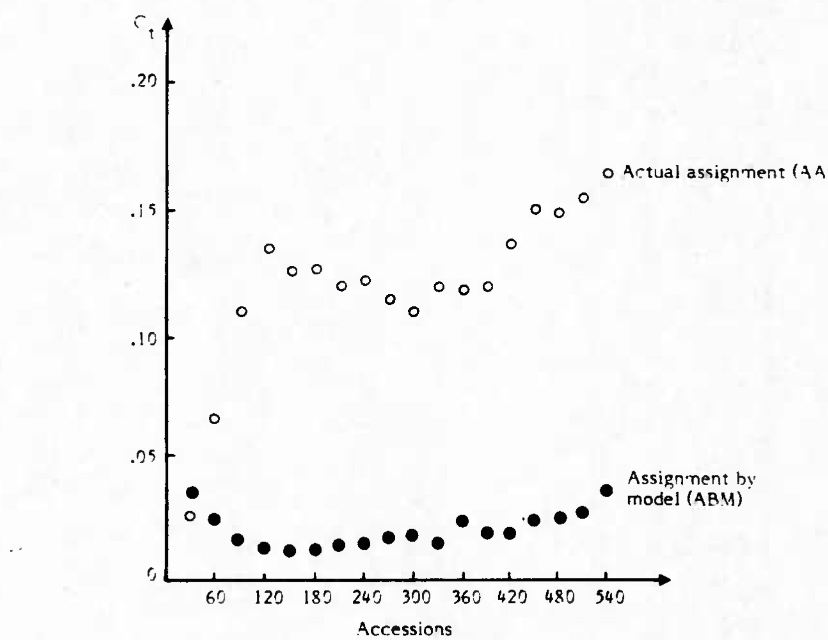

Figure 8. Assignment discrepancy (C_t) across time, February 1982.

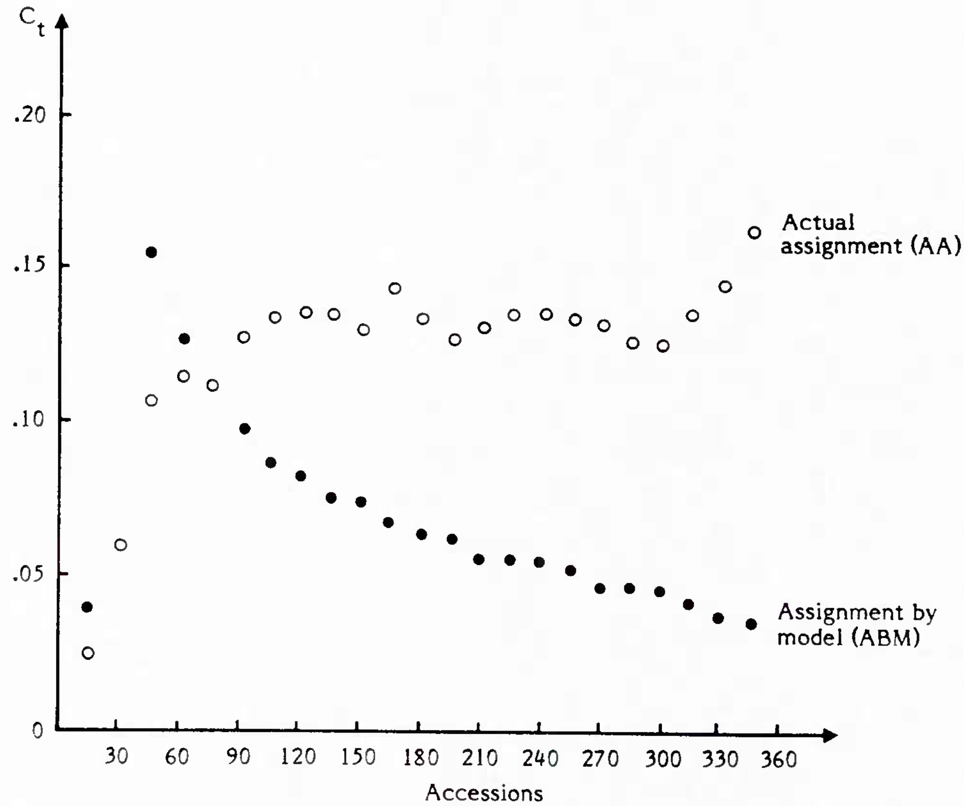

Figure 9. Assignment discrepancy (C_t) across time, March 1982.

CONCLUSIONS

The utility component developed to govern program allocation rates within the REGAL model was successfully constructed and tested, demonstrating personnel allocation closer to objectives calling for uniform program accession rates than the assignments actually made by recruiters.

The component will enable the Marine Corps Recruiting Service to monitor and control program accession rates more effectively by providing instantaneous information feedback, so that recruiters can increase or decrease program allocation rates as quickly as required.

RECOMMENDATIONS

It is recommended that Marine Corps managers at MPI-40 and the Marine Corps Recruiting Service:

1. Incorporate the program fill-rate component into the REGAL module within the ARMS.

2. Initiate research to develop procedures that predict the optimal program fill-rates that will be needed to meet Marine Corps manpower objectives.

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APPENDIX

CALCULATING THE PROGRAM FILL CONSTANT R

The accession status of the system at any given time t depends upon the overall accession proportion, P_t^*, and the separate accession proportions, P_{jt}, for the various programs. Under a uniform fill policy, a condition described by identical P_{jt} values for all programs is desirable. On the other hand, a condition characterized by a large disparity among P_{jt} values is undesirable.

Although a program's accession discrepancy as measured by δ_{jt} in equation 2 reflects positive or negative utility, it is not sufficient to determine utility. Numbers of vacancies within programs also play a role. For example, a discrepancy (δ_{jt}) of size -0.2 may represent a shortage of 1 recruit for a program that requires 4 more to meet its quota, or a shortage of 20 recruits for a program that requires an additional 80 persons.

A sum of squares statistic, based on squared discrepancies weighted by program vacancies, is shown below:

$$R_t^2 = \frac{\sum_{j=1}^{18} n_{jt}\, \delta_{jt}^2}{\sum_{j=1}^{18} n_{jt}} \tag{3}$$

where n_{jt} is the number of vacancies within program j at time t. The mean square statistic, R_t, provides a suitable scaling constant for the δ_{jt} values.

Distributions of R_t were obtained for each of the sample months and medians were used as measures of location. The average of the medians was 0.086 and was used as the fill constant R.

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